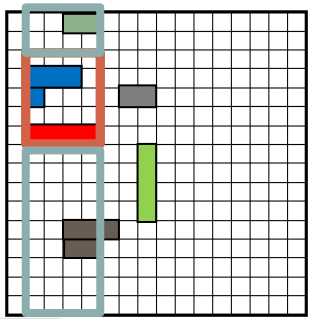
FTK Studies Plan

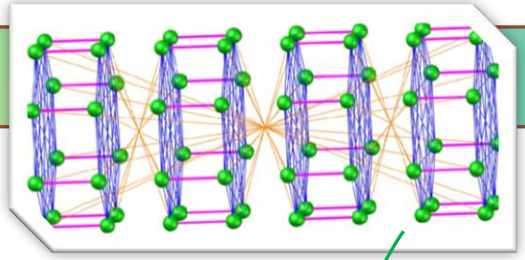
G. Volpi

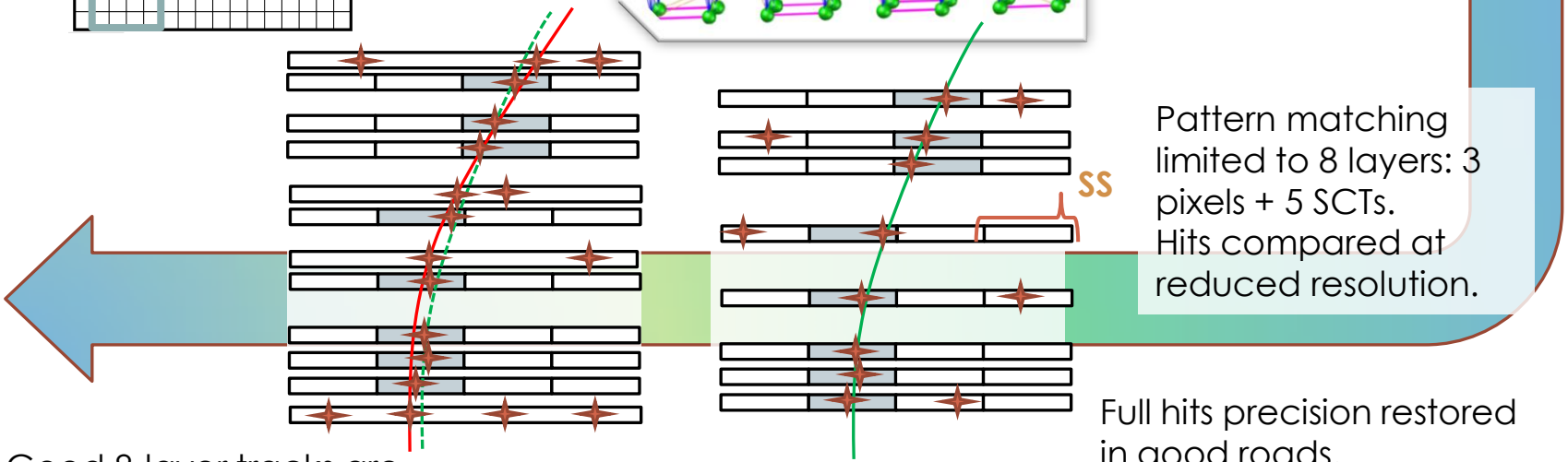
FTK Algorithms Overview

FTK has a custom clustering algorithm, running on FPGAs



The data are geometrically distributed to the processing units and compared to existing track patterns.





Pattern matching limited to 8 layers: 3 pixels + 5 SCTs.
Hits compared at reduced resolution.

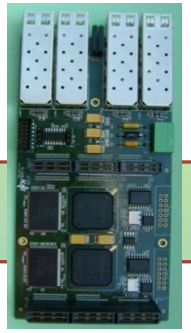
Good 8-layer tracks are extrapolated to additional layers, improving the fit

$$p_i = \sum_j C_{ij} \cdot x_j + q_i$$

Full hits precision restored in good roads.
Fits reduced to scalar products.

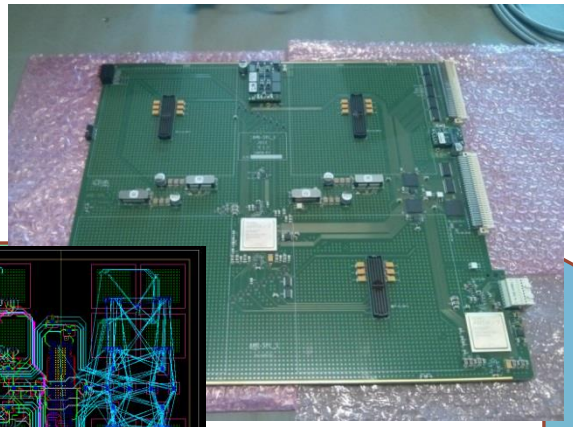
Final design for the boards

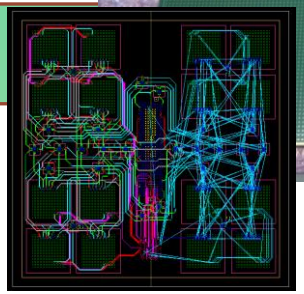
FTK_IM

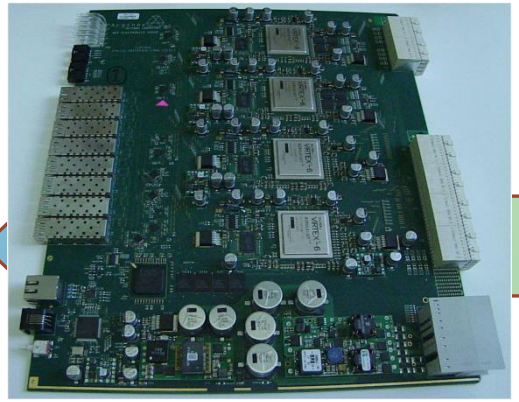


Data Formatter

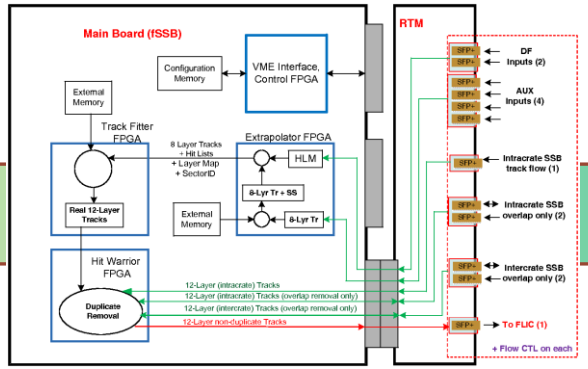
AM board







FTK to Level2 Interface



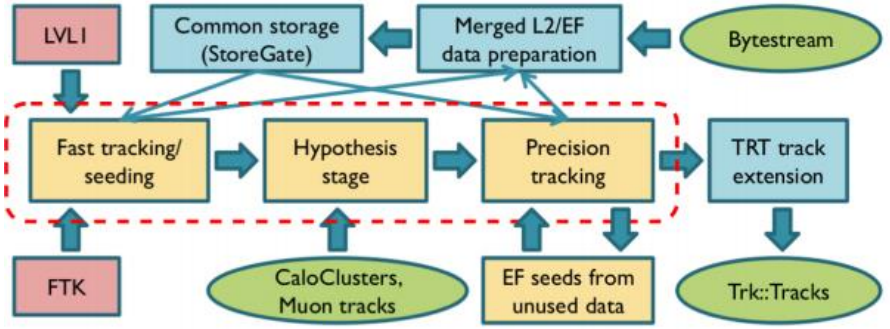
2nd stage board

AUX card

FTK Baseline Configuration

- From the FTK TDR a baseline configuration exists
  - Pattern matching based on 8 layers
    - 3 Pixel layers (w/o IBL), 4 SCT axial side + 1 SCT stereo
  - Final fit using up to 12 layers
    - IBL and additional SCT layers added after geometrical extrapolation
- A pattern size that can suite up to pileup 80 was found
  - 1 billion of patterns, compatible with full system
  - Number of output roads and track combinations suitable for the hardware expected in Run III
- Pattern bank configuration for 2015 ongoing
  - Important to tune the early use of the hardware

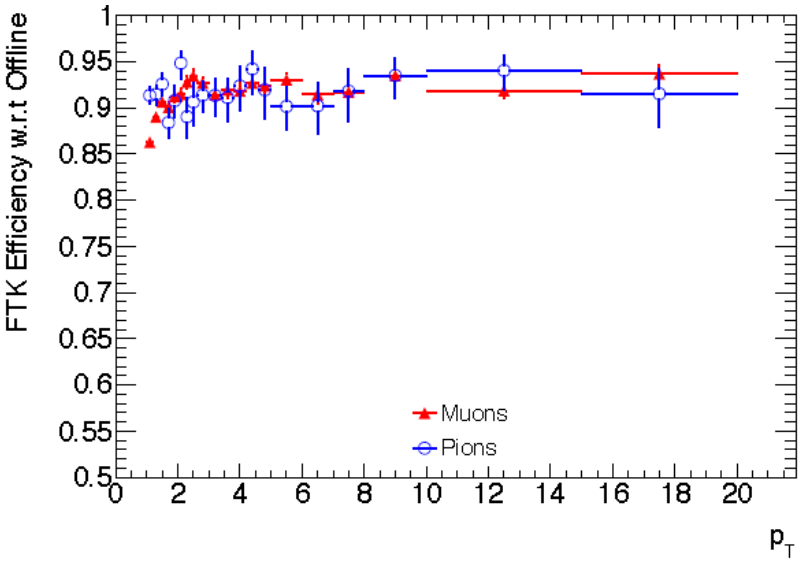
Integration with the HLT

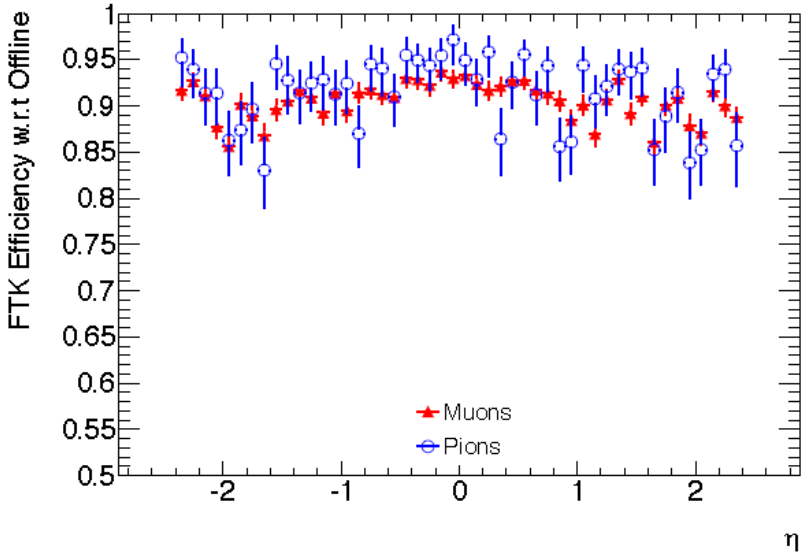


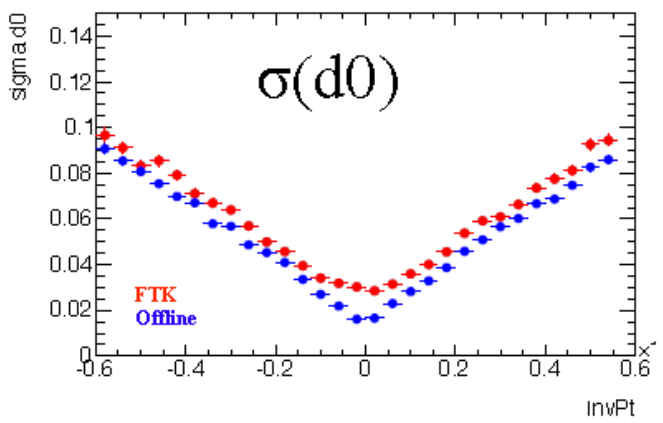
- FTK tracks can be integrated in Athena running the reconstruction
- FTK tracks are present in different flavors
  - TrigInDetTrack, Trk::Track, TrackParticles
- The information can be used as it is or reprocessed
  - FTK "raw" tracks have been tested for B-tagging, vertex reconstruction, taus…
  - Hits associated to FTK tracks can be used in a more sophisticated fit algorithm
    - Kalman filter adapted to use the FTK clusters, being finalized
  - FTK tracks can be used to seed the HLT fit
    - Tests are expected to start soon
- Tracks can be used in common DPD formats

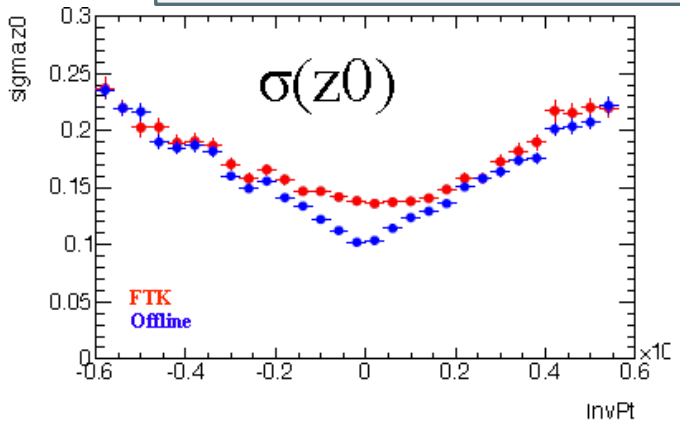
Track efficiency

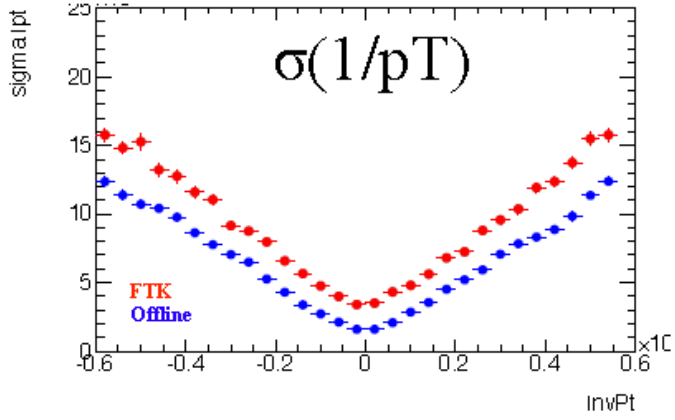
- FTK can reconstruct tracks compatible with the system training
  - |d0(BL)|<2 mm
  - |z0(BL)|<110 mm
  - |eta|<2.5
  - |pT|>1 GeV
  - 9 silicon hits
- Track efficiency w.r.t. offline ~91-92%

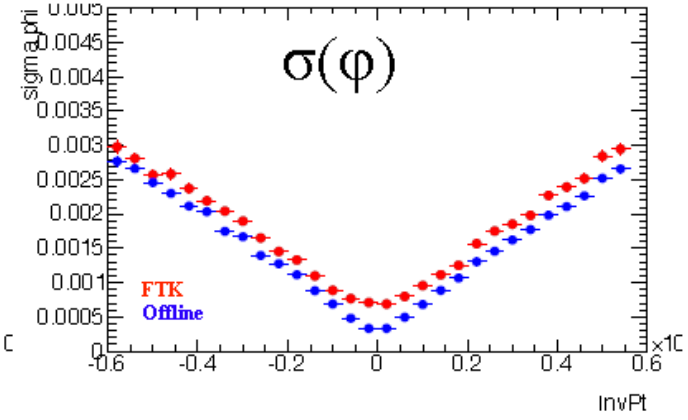


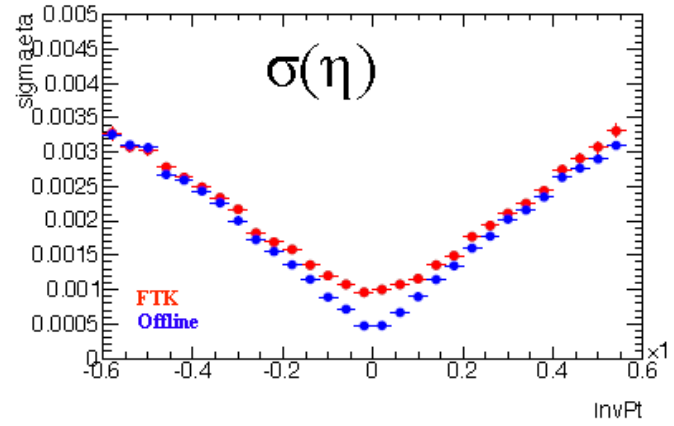












FTK resolution vs 1/pT comparable to offline.
Some residual difference at high-pT under investigation.

Refitting FTK-tracks

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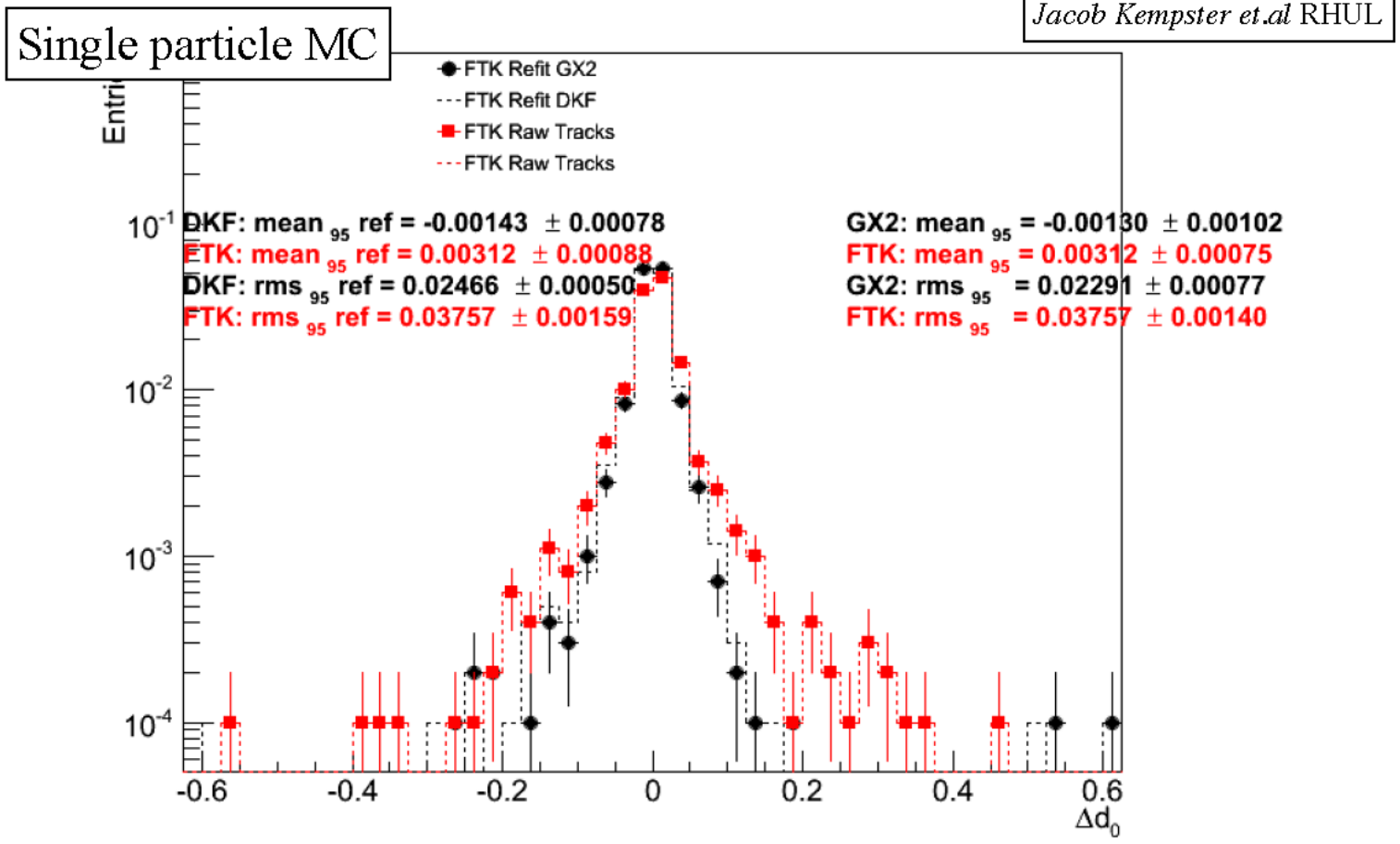
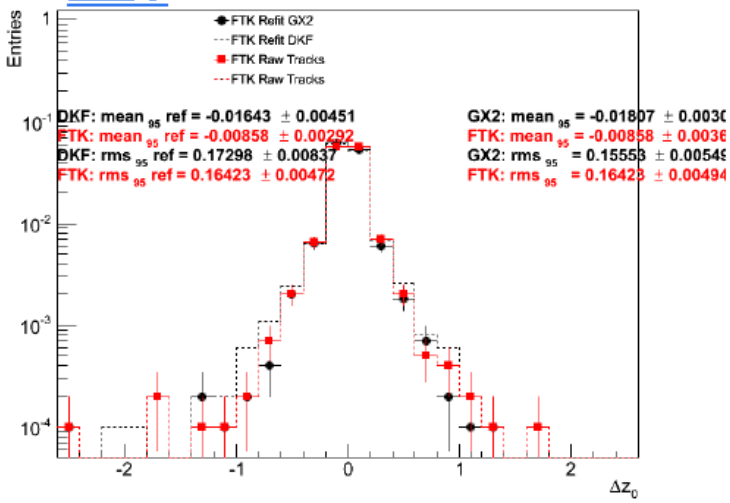
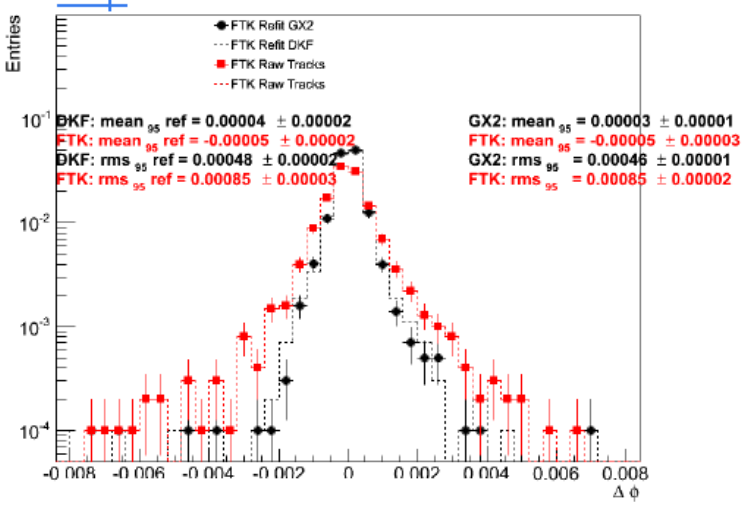


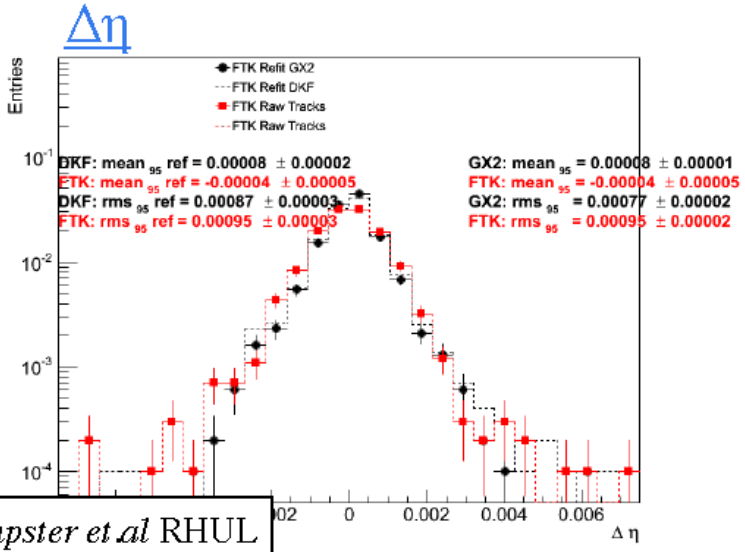
ΔZ0



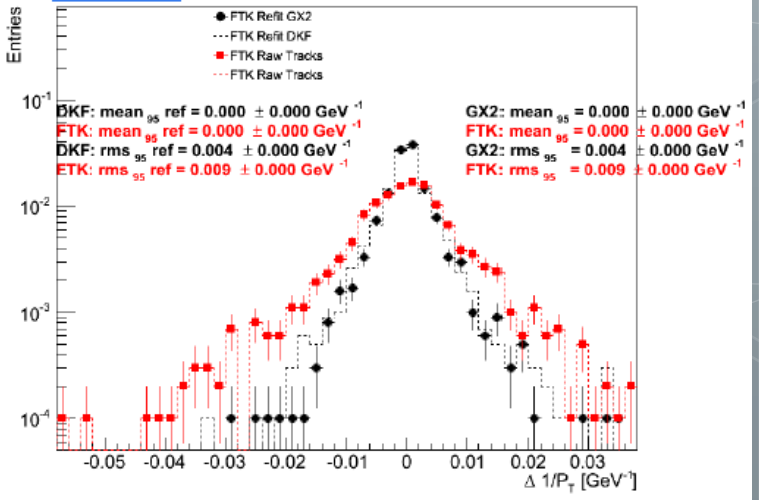
Δφ



Δη



Δ1/Pt



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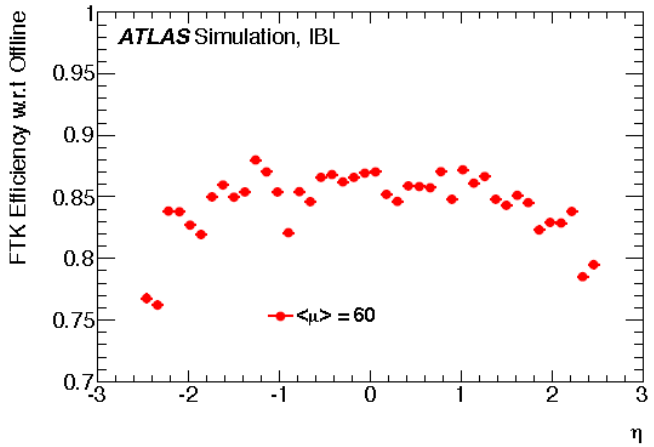
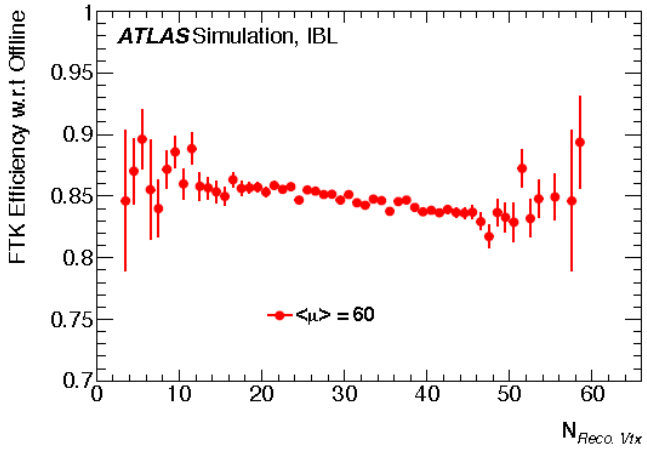
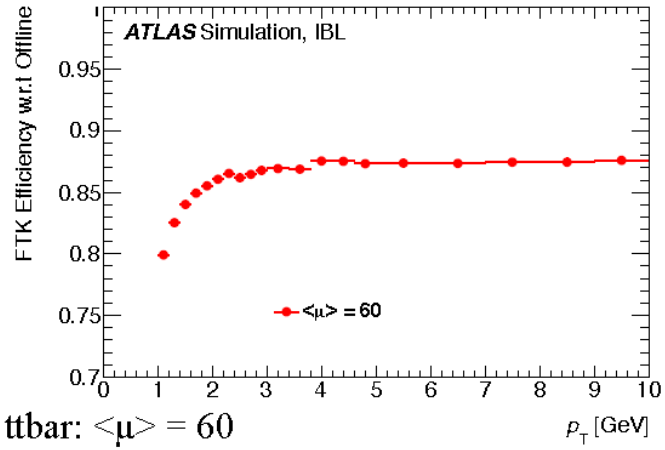
Pileup performance

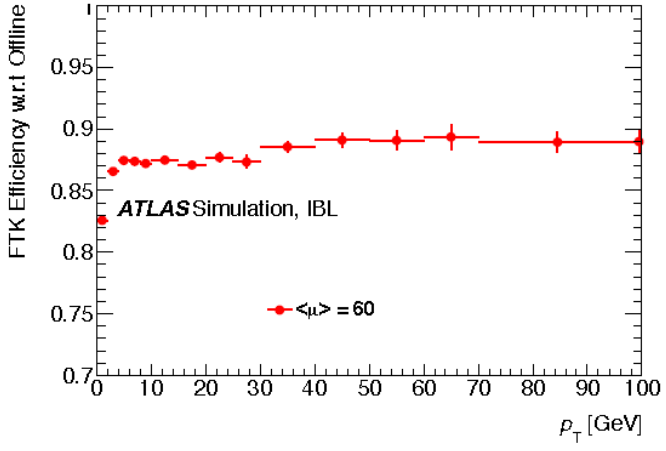
Efficiency w.r.t. offline



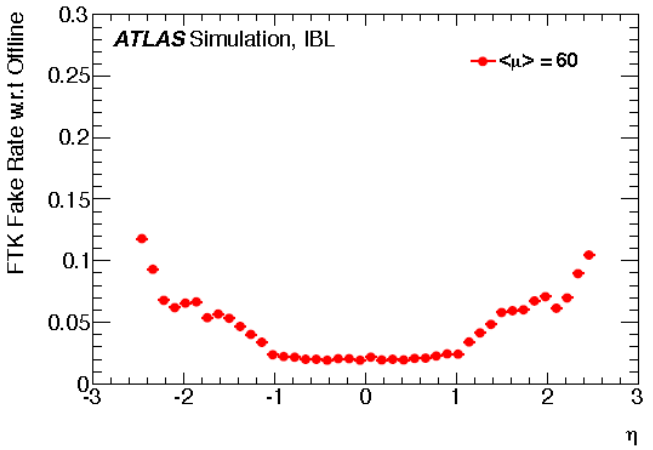


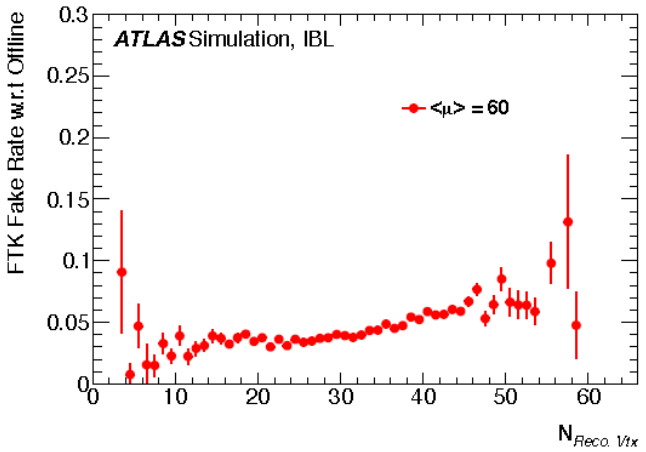


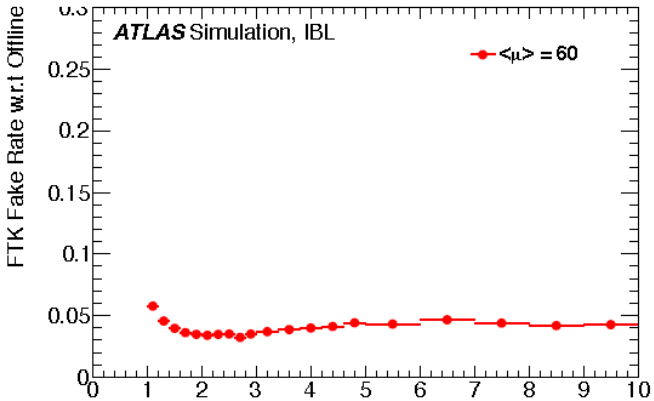
ttbar: <μ> = 60



Fakes







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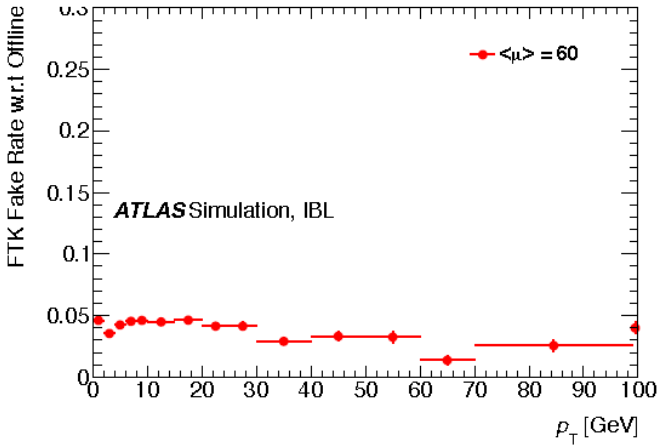
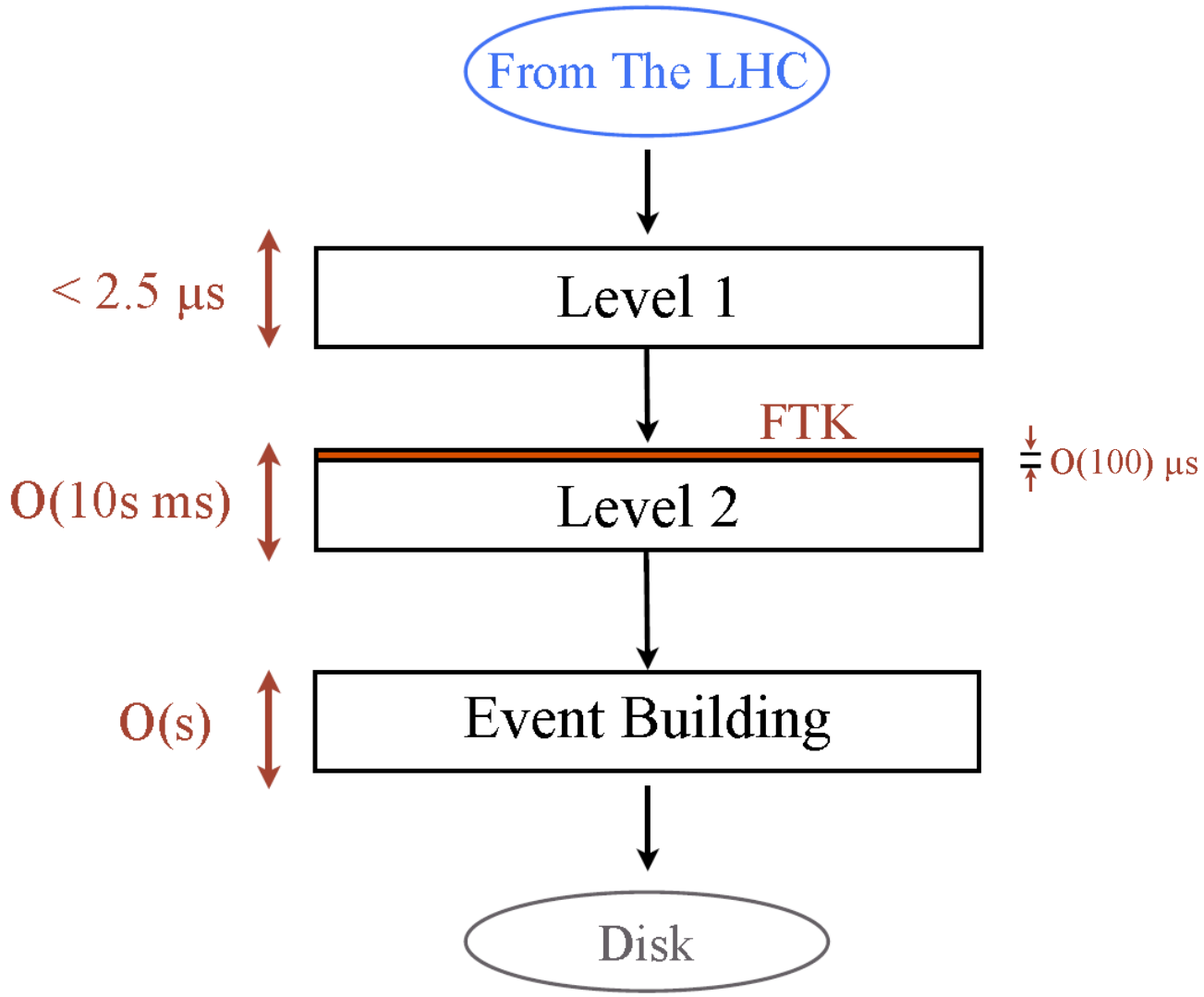



From The LHC
< 2.5 μs
Level 1
FTK
O(100) μs
O(10s ms)
Level 2
O(s)
Event Building
Disk

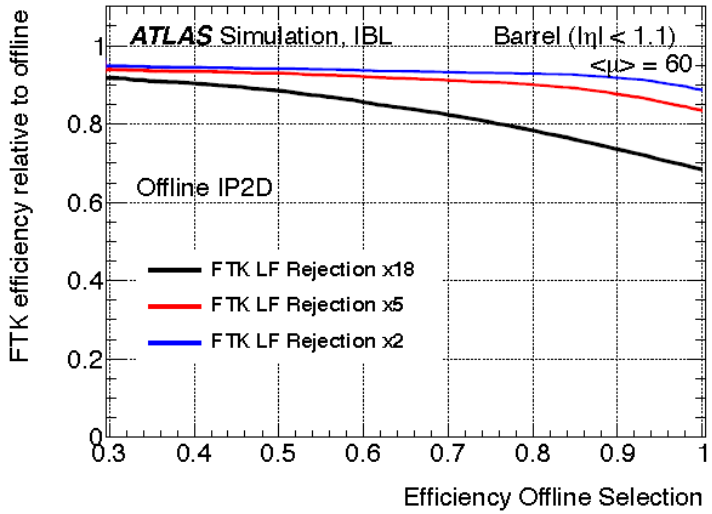
FTK Tagging w.r.t Offline

Efficiency of FTK b-tagging vs offline operating point

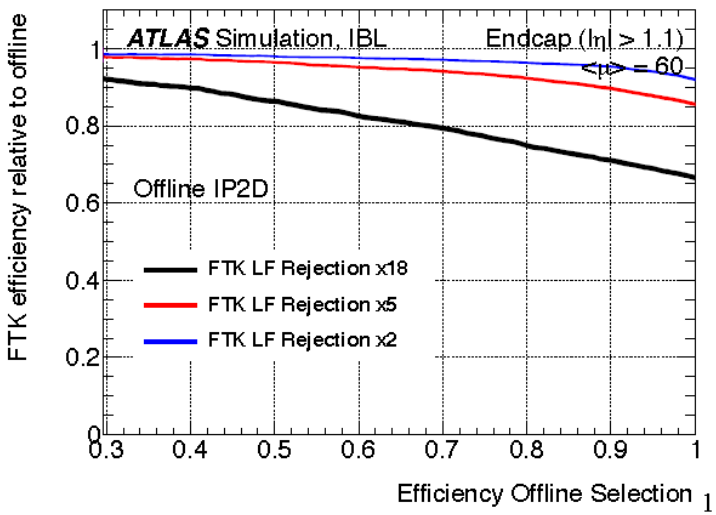
Investigate 3 operating points

- L2 rejection of factor ~2
- L2 rejection of factor ~5
- L2 rejection of factor ~18

Barrel

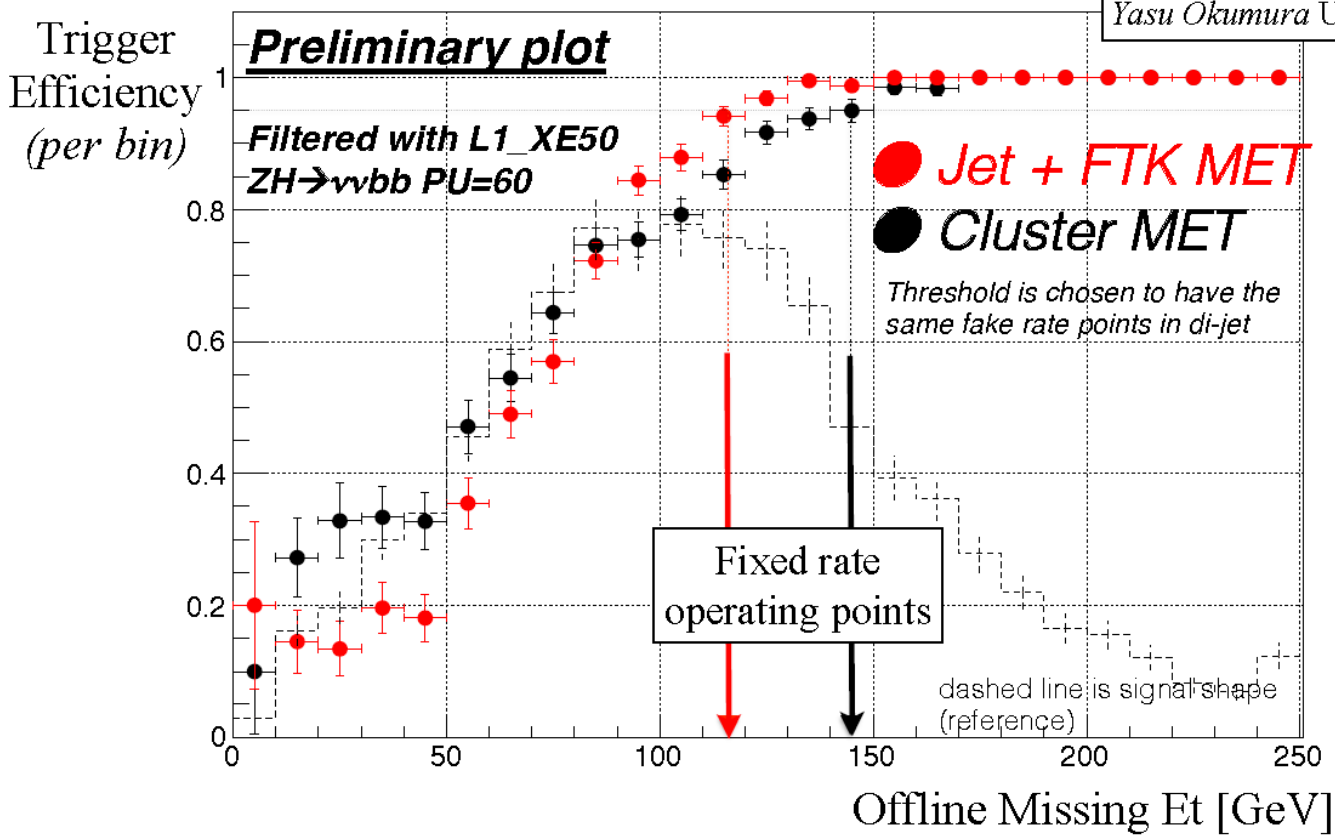


Endcap



MeT

Yasu Okumura UChicago



Conclusions

- FTK baseline performance were studied during the FTK TDR
  - Efficiency better 90%
  - Resolution on the helix parameters mostly comparable to offline tracking
  - Performance suitable for the trigger integration
- HLT integration studies just started
  - FTK tracks can be used to achieve early rejection of background events and allow to implement selections based on full scan at 100 KHz
  - FTK tracks integration with CPU based tracking can allow a good compromise between quality and speed
- Studies just started more to come